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CONTENTS

American Universities: PROFESSOR A. LAWRENCE LOWELL 985

The Annual Meeting of the American Association of Museums 996

Scientific Books:—
Clays, their Occurrence, Properties and Uses: PROFESSOR EUGENE A. SMITH. *Czapek's Biochemie der Pflanzen:* DR. R. H. TRUE 999

Scientific Journals and Articles 1001

Societies and Academies:—
Section of Astronomy, Physics and Chemistry of the New York Academy of Sciences: PROFESSOR WILLIAM CAMPBELL 1002

Discussion and Correspondence:—
The Clock of the U. S. Naval Observatory: DR. W. S. EICHELBERGER. *Variation in the Corolla of Linaria vulgaris Mill:* J. B. TURNER. *The Indian Bedbug and the Kala Azar Disease:* A. ARSÈNE GIRAULT 1003

Special Articles:—
The Solenodon of San Domingo; its External Characters and Habits: PROFESSOR A. E. VERRILL. *A Note on the Hammerhead Shark and its Food:* E. W. GUDGER. *Do Offspring inherit equally from Each Parent?* PROFESSOR MICHAEL F. GUYER. *Thrusts and Recumbent Folds, a Suggestion bearing on Alpine Structure:* BAILEY WILLIS 1004

Quotations:—
Teachers' Salaries and Minnesota 1011

The Award of the Boyden Premium by the Franklin Institute 1012

Scientific Notes and News 1013

University and Educational News 1015

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AMERICAN UNIVERSITIES[1]

MANY of the great industrial concerns of the present day are said to earn their dividends by means of their by-products. Not that their main work is the less essential, but that the keenness of competition has forced the managers to pay close attention to every source of revenue. If this is the case with industry it may be said with equal truth that the benefits of institutions among men often consist chiefly of their indirect effects; and I want to speak to-night of one great indirect influence for good of American universities. By an indirect effect I mean one which is not a conscious object, or at least not one of the prime conscious objects, of existence. The prime objects of a university may be grouped under four heads: (1) giving a general education to a large number of young people; (2) fitting students by a special training for the practise of a particular occupation or profession; (3) maintaining a body of scholars who add to the sum of human knowledge; and (4) recruiting the men who are to succeed them—for with a really great scholar the problem is not so much to teach him as to discover and stimulate him. Now for the attainment of these four objects various organs of the university have been established.

[1] Address delivered at Yale University on April 19, 1907, being the third of the annual Harvard lectures. The fund for this course of lectures was provided by an anonymous Harvard graduate. The first lecture was given in 1905 by President Eliot, and the second in 1906 by Professor George H. Palmer.

These are the academic department, the professional and graduate schools, and the instructing staff. Not that each organ pursues a single aim, or that the ends desired are always logically, nor perhaps most effectively, promoted by the present subdivision of our institutions, but each organ purports, at least, to lay particular stress on one of these objects.

In addition to these objects our universities and colleges are yearly rendering another great service to the whole country, by helping to create a universal standard of citizenship, to diffuse an American ideal, and it is of this that I wish to speak.

Men whose lives have passed the half-century mark can remember, after the reconstruction of the south was over, loose talk about the next split coming between the east and west; and there were people who really felt that the Atlantic seaboard and the prairie differed so much in material interests and methods of thought that the republic might not improbably be hereafter rent along the line of a meridian. The suggestion would only provoke a smile to-day. The railroads and the growth of manufactures in the west have so blended the interests of the different sections of the country that such an idea has become an absurdity. Nor has the nation become more homogeneous on the material side alone; for the intellectual and moral bonds have been drawn closer also, and in this the universities have had no small share.

But if the sectional specter no longer frightens timid souls, we still suffer acutely from a lack of uniformity of national standards in other directions. Any candid observer of the business methods revealed by the investigations of the New York life-insurance companies, and of the discrimination on the part of the railroads, can hardly fail to perceive that the misconduct which shocked the public was due at least as much to the lack of moral standard as to the deliberate violation of recognized rules of honesty. Two men quarreled publicly over the control of a great insurance company, both of them clearly unconscious that there was anything reprehensible in the methods of administration; but when the management was exposed to view, the community was shocked and a cry was raised for reform. In the same way discriminating freight rates were demanded and given a score or more years ago without a sense that the transaction differed essentially from a reduction made to a large customer by a private manufacturer. Every one, indeed, who has had anything to do with the centers of business life in this country must have been struck with the lack of a fixed code of principles in the management of corporations; and he must have seen both the snare this spreads for the unwary, and the explosion of lack of confidence caused by the uncovering of an extreme instance of a kind of thing that everybody knows is constantly occurring in a milder form. The rules that ought to govern the relation of a director of his corporation in matters of underwriting, in the matter of financial operations with bankers or brokers with which he is connected—many things of this kind are to-day in a state of uncertainty, and the series of business transactions goes by imperceptible degrees from a perfectly honorable act at one end of the scale, to an act at the other end that excites general indignation when it is revealed; and yet there is no point at which a line can be drawn and a warning given 'thus far shalt thou go and no farther.' Often in human affairs it is more important that a line should be drawn than it is at what precise point that line is drawn; for 'where there is no vision the people perish.' The fact is that the new business methods, the new possibilities of combination on a gigantic scale, have made old canons inadequate, and brought the

need of a new code of business morality. The nature, and still more the size, of modern transactions have affected the relations of men to one another, and made things wrong that were not wrong before. It is right for each man to trade or work where he pleases, but when a great combination is used to wreck a rival or coerce an industry we are brought face to face with another problem. The boycott and the trust have unsettled many old convictions; and when the accumulation of capital in a corporate form throws into the hands of the managers the power to enrich themselves by imperceptible tributes levied on innumerable stockholders, as in the case of a reorganization or a loan effected for the general benefit of the company, we feel the need of stronger rules fixing the rights and duties of directors. One naturally looks to the courts to lay down the principles of fair dealing in such cases, but while the rapidity with which vast business transactions are negotiated has increased beyond precedent, the machinery of our courts has by no means kept pace. A momentous trial takes longer than ever before, and in affairs of great magnitude, justice, if not uncertain, is at least remote. Thus it happens that the courts have not been fully able to cope with the present industrial conditions, and the law's delay is an impediment to the maintenance of sound business principles in one part of the country, as it is to the prevention of crime in another.

An orgy of political misrule, fostered by the moral lassitude following the strain of the civil war, stirred the national conscience a generation ago. Earnest men, mainly college graduates, spoke and wrote on the subject until something like a standard of political probity was generally recognized. It was not at once carried out. Politicians, especially in municipal affairs, do not live up to it yet. But the standard must come first, its enforcement afterwards, and there can be no doubt that our public life is far purer than it was at the time of the Credit Mobilier, the whiskey frauds and the Tweed ring. The public, indeed, demand to-day a stricter standard in political than in commercial life. They demand of a legislator or an executive officer a more scrupulous avoidance of dealings in which he may have a pecuniary interest, than they do of the director of a corporation; and that is one reason why they regard with complacency a degree of government control of industry that would have been repudiated with disgust a generation ago. One of the crying needs of our time, therefore, is a well-recognized code of commercial honor.

Now, it would be absurd to suppose that universities can manufacture standards of business morality. But they can help to diffuse the fundamental principles on which all morality must rest; and, what is far more important, they can bring men into that intellectual sympathy, that common way of looking at things, which must exist before an agreement on principles of any kind can be reached. Our universities do, in fact, help to set up standards of life and thought, and thus create a national unity of principles in several ways. In the first place, the instructors themselves tend to be more and more alike in their aspirations and methods of work in all our widely scattered universities. The graduate schools, where they study their special subjects, and prepare themselves for their future career, have had a marked effect in this direction. To use a highly inappropriate metaphor, these schools shuffle the pack very thoroughly. One of the pleasantest features, indeed, of the growth of the graduate schools has been the migration of students. A young man from Missouri, for example, who has graduated—let us say —at Oberlin, may come to Yale for a grad-

uate course. He may then get an instructorship at the University of Texas; and if he does well he may be offered an assistant professorship in the University of California; and finally be called to a full professorship at the University of Michigan. Nor is such an imaginary career an exaggeration of what is continually happening. Every considerable graduate school has planted its sons in universities throughout the land; and everywhere that such a man goes he spreads the light from the place he has come from, and gets more light from the men that he meets in his new place. Methods of work, and tone of thought, as well as pure knowledge and ideas, are diffused by such men far better than they can be through books, which contain only the final results of scholarship. The many learned bodies that have adopted the habit of meeting during the Christmas recess, composed almost wholly of professors, are most suggestive illustrations of how homogeneous in tone our universities are from one end of the country to the other. The college faculties form, indeed, one great brotherhood, with common aspirations and tone of thought, a brotherhood that has its ramifications everywhere, and everywhere has charge of the great sources of the intellectual life of the future.

But the work of the universities in bringing all parts of the nation into intellectual harmony is not due solely, or perhaps mainly, to similarity in the corps of instructors. It results also from the fact that the students themselves come from all parts of the land. To take first the purely professional schools: A student coming from wheresoever it may be, who learns his medicine at Johns Hopkins, his engineering at Yale, or his law at Harvard, goes back to his home not only with a knowledge of his profession, but a broader man than he was before; and he never loses the inspiration that comes from study in a really great school. He has a higher ideal, a broader outlook, than he could have acquired in a merely local institution, however good the purely technical teaching might be; and everywhere that he practises in after-life he helps to maintain the principles of his profession, and to advance its higher interests better, because he has studied in a school of national reputation, where students come from every part of the United States. In such a case it is clearly an advantage that the men from different places should be brought into as close contact as possible; and, therefore, I have regretted that the graduates of Yale, who come to the Harvard Law School in considerable numbers every year, should have fallen into the habit of living together in a remote dormitory, instead of being scattered among the other students of the school. Their classmates would benefit greatly by being thrown with them more intimately, and no doubt they would also gain something themselves. From the same point of view the policy on the part of all ambitious universities of establishing schools to fit for every conceivable profession may be open to serious objection, especially in cases where the total demand of the community for members of that profession is small. Are we not sometimes in danger of sacrificing the general welfare to the desire of an institution to be complete in itself?

But, after all, the strictly professional schools—and for that matter the graduate school, which is mainly a professional school for teachers of secondary or university grade—all these schools touch men mainly at one point. The thoughts of the students there are so centered in the subjects they are studying, that while there can be no doubt that they get much good from their fellows in many other ways, nevertheless the broadening influence of the university upon them is brought to bear chiefly through their special line of work.

It is in the undergraduate department—the college, as we like to call it—that the university can best exert its broadening power, can bring men from different places into closer fellowship and thereby give them common ideals and a national type of manhood. So far as college students are serious-minded—and they are so more than they always like to admit themselves—they are thinking not of training themselves to earn a livelihood, but in a more or less conscious way of some portion of the riddle of the universe. Moreover, they come to college at an impressionable age, when their ideas and characters are easily molded into new shapes which are often retained through life. At such a time an acquaintance with men from distant states, and especially a real friendship with one or two of them, will have an effect in slackening prejudices, and creating common ideals, that might come later only after years of experience, if at all. Some time ago one of my students from the far south said that it would doubtless have been pleasanter for him to have gone to a southern college, but he knew that if he did so he would be a southern man, whereas he wanted to be a national man, and therefore had come to us. Before he left Cambridge he became very intimate with a student from the state of Washington, and they are now both practising law in New York. It is needless to say that my friend is a national man, and the kind of man whose presence will be a benefit to New York, or any other place where he may live; to say nothing of the fact that his being in New York will also be a benefit to the southern state from which he came, by helping the people of the north to understand the feelings of the south. That such an object should be deliberately sought and followed is perhaps unusual, and proves rare perception, or maturity, on the part of my friend; but that it tells unconsciously with many men, and that thousands more have got the benefit of the principle without ever having thought of it, is undoubtedly true.

At one time the Italian government was in the habit of sending the young recruit in the army to a garrison town in a distant part of the country. The Piedmontese might go to Calabria, the Neapolitan to Tuscany and the Venetian to Rome; the object being to break down sectional feeling, and bring about a stronger national sentiment and a greater sympathy between the different provinces. The same object on a far higher plane is attained to some extent by our own colleges.

The value to civilization of the great European universities at the close of the middle ages, with their swarms of students from every part of Christendom, can hardly be overestimated. They brought all educated men into a single intellectual fellowship, and prepared the way for the reception of new ideas, and the expansion of thought. It is not easy for us to realize how great a part they played in the life of their time, because thereafter the universities dwindled in size, and only in recent times have they begun again to rival in numbers the crowds that gathered from every nation in Europe at Salerno, at Bologna, and at Paris. Hence one finds it hard to shake off the impression that they are a modern growth. In America the aggregate body of students at institutions of higher learning has been increasing rapidly for many years, not only in actual numbers, but also in proportion to the population. Our universities are not only growing larger, but their influence is extending in wider and wider lines through the body politic. Instead of being merely places where young men of means could enjoy the luxury of a liberal course of study, and where the youth aiming at a professional career could get their training, with such a general education as was

thought necessary as a foundation therefor, they aim to-day at diffusing learning directly or indirectly through all strata of society, helping to bring light to any one who wants it. This is especially true of the western universities, which are truly institutions founded by and for the whole community, and which enjoy a marvelous popularity. The opening of a wider door to the influence of the university makes it all the more important that that influence should be exerted in the best possible way, and hence that so far as possible it should not be a local institution, but one which brings together young men from all parts of the country. Looked at from the point of view of the public welfare rather than that of the individual student alone, this is so much one of the chief objects of our colleges that should a general custom arise for every man to attend exclusively the university in his own neighborhood, it would be a great misfortune to education in America. One may, therefore, question whether the part of the sums which the General Education Board is proposing to spend in fostering local institutions all over the country could not be more wisely spent in assisting young people to go to the greater seats of learning. The strongest among them would find larger opportunities of pursuing their studies, and they would all go back with a wider outlook, a better intellectual horizon, than they could get at a small college nearer home.

It may be interesting in this connection to note the geographical distribution of students in some typical American universities. It is difficult to give the figures with perfect precision. In the first place because, as found in the publications of the university itself, they sometimes include the summer school, for example, and sometimes do not; and there are inaccuracies arising from duplicate registration which are not easy to eliminate. Nor is it always perfectly clear what ought properly to be included in comparing the work of the different universities. That the students of a summer school stand on a different footing from those who take the regular course is evident. As a matter of fact, they usually come in the main from no great distance; and hence it would be manifestly misleading in the case of a university whose permanent students were very widely distributed to reduce that degree of distribution by including the figures for the summer school. The same thing is true of the short-term agricultural courses given by many of the western institutions. In comparing different universities, therefore, an attempt has been made to leave out courses of this sort, as well as merely evening schools, while including all the branches of the university where the period of study covers the regular term. But as I have already said, it is difficult to get figures exactly, and those cited here must be looked upon as merely approximate.

Most of the largest American universities have at least one student from almost every state and territory in the Union; but the proportion in which they come from the different parts of the country varies a good deal. Taking Yale, Princeton and Harvard as types of the older institutions, which are large and have flourishing undergraduate departments, we find that the proportion of the students who come from a single state runs from 25 per cent. to 50 per cent., 25 per cent. being the case of Princeton, which, situated in New Jersey, has naturally less students from any one state than Harvard in the populous commonwealth of Massachusetts. In fact, Princeton draws her largest number of recruits from Pennsylvania. Now, these figures mean that in those three universities from one half to three quarters of the students come from states other than the one that supplies the largest contingent.

The proportion of men from outside the state is, indeed, large in almost all the great institutions that are not supported by taxation. Cornell, for example, gets 56 per cent., and Oberlin only 50 per cent., of their students from their own states, in spite of the great size of the states of New York and Ohio. This is true even of some of the smaller colleges of this kind. Amherst and Williams, for instance, receive from a single state only 36 per cent. and 40 per cent. of their students, the former drawing her largest number from Massachusetts, the latter from New York.

I have spoken of all these institutions as not supported by taxation, for among the most valuable of the experiments in education that we are trying in America, is that of two classes of universities side by side, striving for the same ends, doing the same work, but supported and governed on a radically different plan. All the best of the state universities have outgrown the stage when politics hampered their usefulness, and are now very close competitors of the older institutions. The most flourishing of them are in the central and western states, but the line between the two classes being by no means strictly geographical, I shall refer to the institutions that are not maintained and controlled by the state as endowed universities. Not that the state universities are wholly without endowment from private generosity. Some of them have received considerable sums in this way, but as President Pritchett has pointed out in the first bulletin of the Carnegie Foundation, the most vigorous of the state universities have been as a rule the ones that have thrown themselves most completely upon the state and obtained the smallest fraction of their support from private benefaction.

With state and endowed universities running a very close race, with their professors constantly interchanging places, with little advantage on either side except what may flow from the different method of support and government, one approaches with interest a comparison between the two in any field; and not least this question to what extent they draw their students from afar. We have seen that Yale, Princeton, Harvard, Cornell, Oberlin and even Amherst and Williams, receive only from 25 per cent. to 56 per cent. of their students from any one state. Now Michigan appears to be the only state university that attracts any such proportion of her students from outside the state to which she belongs. In her case 54 per cent. of the students come from her own borders; while in the universities of Wisconsin (80 per cent.), Minnesota (89 per cent.), Illinois (83 per cent.), Missouri (78 per cent.), Kansas (91 per cent.) and California (91 per cent.), the proportion that comes from the state itself runs from 78 per cent. to 91 per cent.; the average for these six institutions being 85 per cent. The figures are certainly significant. So far as they go they seem to show that in the endowed universities, or at any rate in several of the principal endowed universities, less than one half of the students come from any one state, but that in the state universities four fifths, or more, commonly come from the state itself.

We should, no doubt, reach a similar result if instead of inquiring how many students came from a single state, we neglected political divisions altogether, and found how many came from a geographical area or zone within a given distance from each university; but to do so would naturally involve a very elaborate investigation. The same object may, however, be roughly attained by taking the percentage of students who come from the six states most largely represented in the university. As a result of this computation we find that Yale draws 24 per cent. of her students from parts of the United States out-

side of the six states that furnish her largest contingent of recruits; and in fact of all American universities Yale is the one whose students, in proportion to their number, are most widely distributed over the nation. Princeton draws outside of her six leading states 22 per cent.; Harvard 21.5 per cent.; Oberlin 19 per cent., and Cornell 16 per cent.; while both Amherst and Williams, in spite of their small size, draw 18 per cent. Michigan, the state university whose students are by far the most widely distributed, draws 14 per cent. of her students from parts of the union lying beyond the six states that give her most recruits. The University of Missouri, with her wide southern clientele, draws 12 per cent.; Illinois, 8 per cent.; Wisconsin, 4 per cent.; California, less than 3 per cent., and Minnesota and Kansas, only 1 per cent. each.

These figures make no pretense to be a statistical abstract of the distribution of students in our universities. They are taken from a few typical institutions alone, and, as I have already pointed out, they are not perfectly accurate. Still they are trustworthy enough to form a basis for some conclusions, not indeed very new or startling, but by no means without interest. They show that on the whole the endowed universities draw their students from a much greater area than the state universities, or rather draw a larger fraction of their students from all over the country, for, as we have seen, almost every great university draws at least one student from almost every state and territory.

Such a difference is important in view of the large size and high degree of excellence which the state universities have attained. No doubt it is in part due to the greater age of most of the endowed institutions, for the graduate of a college planted in a remote region becomes a recruiting agent for his alma mater. He advises the young fellows that he meets to go to the place where he received his own education, and in due time he sends his sons there. If he achieves success, that also works as a perpetual advertisement of his college. This suggestion of the cause of wide distribution of students is to some extent confirmed by the fact that the University of Michigan, which is the oldest of the state universities referred to, and far the oldest of them in reputation, draws her students from all parts of the country much more than any of the others. But the University of Wisconsin, founded only twelve years later, draws 80 per cent. of her students from within the state and only 4 per cent. outside the six states that give her the largest support. Moreover, if we compare Cornell with the universities of Illinois and Minnesota, which were founded at almost the same time and are about the same size, we find that Cornell draws only 56 per cent. of her students from the state of New York, while the Universities of Illinois and Minnesota draw 83 and 89 per cent., of their students from their respective states; and that from the parts of the union outside of the six principal states Cornell draws 16 per cent. of her students, while the two state universities draw only 8 per cent. and 1 per cent.

The apparent difference in the area from which students are drawn may also be due in part to the fact that all the state universities are coeducational, while the great colleges on the Atlantic seaboard which have been cited are not; and it is undoubtedly true that parents are more reluctant to send their daughters than their sons to a distant place for their education. But this motive does not apply to Cornell and Oberlin, which have admitted women freely from the start. It may, indeed, be urged that these two institutions stand in a somewhat peculiar position, and a position that has tended in the past to extend their renown and their influence over the nation.

Each of them was in her own way a pioneer in education. Each of them stood for an idea, and was in her early years radical, aggressive and militant, a condition that tends to attract persons of a like way of thinking wherever they may live. It is, of course, impossible to estimate the effect of conditions of this kind, or to allow for them in making a computation of results. Nor is it easy to select endowed and state universities whose circumstances have been so completely identical as to make comparison absolutely fair.

Perhaps the best example to be found is that of the two great universities on the Pacific slope—Leland Stanford, Jr., and the state university in California—and a comparison of these two is instructive. The University of California has been in existence more than twice as long as Leland Stanford, and is nearly twice as large; so that she ought to have an advantage on the score of both age and size, and both institutions virtually admit citizens of the state free, and charge fees of $20 a year to non-residents. Yet the University of California draws over 90 per cent. of her students from the state alone, while Leland Stanford draws 62 per cent. from that state. The students at the University of California came, according to the catalogue of 1901–2 from which these statistics are compiled, from only 29 states all told, while to Leland Stanford they come from 42. Moreover, less than 3 per cent. of the students at the former came from parts of the country outside of its six chief tributary states, as against 13 per cent. in the case of Leland Stanford. Some slight allowance must, no doubt, be made for the fact that Leland Stanford limits the number of women to 500, while at the University of California they form a decidedly larger proportion of all the students. But this is a trifling matter that could hardly affect the result seriously.

If all this array of figures does not warrant any precise quantitative comparison of the distribution of students in the different kinds of institutions, it is surely definite enough to prove that, so far as drawing from a wider area is concerned, the endowed universities are doing a more fully national work than those which are supported by state governments; and it suggests, at least, a probability that in the future they will continue to do so. There are a number of reasons why this should be the case. About half of the state universities now make some distinction in fees between citizens of the state and other people; and with the continual increase in the cost of instruction the practise is likely to grow rather than decline, for it seems unreasonable that taxpayers should be burdened to provide education for outsiders. They have been certainly extremely liberal hitherto, and a young man can go to-day more cheaply to a state university in another state that charges a differential fee, than to one of the eastern colleges.

Then there is the matter of state pride. If a boy intends to go to any state university there is a motive of local patriotism for going to his own. Is not his own as good? Is it not established, paid for and conducted, for just such as he? Is it not striving to swell its numbers? Finally, there is the question of the allegiance to his college of the graduate living in a distant state, the affection with which he looks back to it, and the eagerness with which he sings its praises. This sentiment is said to be less strong in the case of the state, than of the endowed, universities. Such a difference, if it exists, may be due to the fact that a state university, like a high school, is taken as a matter of course, as one of the regular organs of the government, and not as an institution in which a member has acquired a privileged proprietary right. Something may be due to the more common

custom of endowed universities of lodging their undergraduates in dormitories, thus giving them a real community life; and something to the practise, common, though not universal, of allowing the alumni a voice in the selection of the governing board. If such a difference in sentiment exists, whatever the cause may be, it will exert a potent influence in favor of recruiting the students of endowed universities from a wider area. But the state universities have already astonished and delighted the world too much to make safe any predictions about what they will or will not achieve in the future.

It would appear, however, that bringing young Americans together for a common education from every section of the country is at this present day preeminently the problem of the endowed universities, and especially of the larger ones; for, while some of the smaller colleges draw their students from a wide area, the larger institutions are peculiarly fitted to work on a national scale. Their very size means a wider constituency, and hence a more complete mingling of young men from all over the country. They are best adapted for the great function of helping to form a national type of manhood, because they have a better chance of drawing students in large numbers from every part of the land. But if size gives opportunities, it involves also difficulties. In a small college the individual is in less danger of being lost; the young man without aggressive personality is less likely to be ignored or submerged. Character and self-reliance are more developed by being a man of mark in Ravenna than by belonging to the mob in Rome; and what is more to our purpose, a body that is too large for general personal acquaintance tends to break up into groups whose members see little of one another. The citizen of a good-sized town has usually a wider acquaintance than the dweller in a big city.

In the social life of a college, as in other things, there is for any one form of organization an economic scale which gives the best results. Beyond that the social body becomes fissiparous, and thereby loses the benefits of size. What is worse, the lines of cleavage naturally follow the associations formed before coming to college; and hence a man from a distance, who has no friends already there, may well fail to become intimate with the men whom it is most important that he should know both for their sake and his own. In many places the social life of the students is regulated by fraternities, to some one of which almost every undergraduate belongs; and such a system may work well enough in a small college, or in one where the students come from a limited area, so that every one has a chance of being known. But in the large endowed universities that system, or any system of societies or clubs, is incapable of supplying an opportunity for the best kind of social life to the great mass of students. Nor if it could include them all would it be a fortunate arrangement, because here again we should be met by the tendency to divide on the lines of previous association, and one of the chief advantages of the great university, that of throwing together men from every part of the country, would be in great part lost.

Now, the larger colleges grow, the more pronounced this difficulty must inevitably become. In the largest of them it is already felt; in others it can be foreseen; and before many years have passed it will present a very pressing problem. With the rapid growth of the number of people who can afford to send their sons to college, with the ever greater need of education as a prerequisite to getting a good start in life, and with the tendency to require a college degree before beginning the study of a pro-

fession, there is every reason to believe that the total number of college students in the United States will increase very fast. If, therefore, the undergraduate departments of the larger endowed universities maintain their hold upon public confidence, it seems not unreasonable to suppose that in the space of a generation they may triple or quadruple in size; and before that happens the question of student life must be solved, or will have solved itself, for better or worse.

The problem is so to organize the students as to mix together on an intimate footing men of all kinds from all parts of the country. The obvious solution is to break the undergraduate body into groups like the English colleges, large enough to give each man a chance to associate closely with a considerable number of his fellows, and not so large as to cause a division into exclusive cliques. It must be understood, of course, that this applies only to the social life, not to the instruction, which would remain a university matter as heretofore. Such a suggestion of breaking up the student body has often been made, and something of the kind must be done sooner or later if we are to maintain our old ideas of the value of college life. Incidentally, it would have the effect of provoking internal emulation which we sorely need. The socialistic, or for this purpose it is more appropriate to say the Christian, spirit that has come over the world has affected profoundly our undergraduates. Of late years an appeal to purely individual objects has less effect upon them than it did formerly. A student likes to feel that he is striving not for his own selfish fame alone, but for the glory of the organization to which he belongs, and hence a rivalry between a number of colleges would add a powerful incentive to effort in many lines.

But it is not enough to suggest that the undergraduate body can advantageously be divided into groups; the difficulty comes in arranging how the groups can be formed; and here we get very little light from European experience. The German universities, and those that have followed their model, are collections of professional schools training men to be clergymen, lawyers, physicians and teachers or professors. They have nothing corresponding to the liberal culture at which our college purports to aim. That phase of education is supposed to be completed at the gymnasium. In England, on the other hand, where the universities have developed the ancient traditions in a very different way, the social conditions are such as to preclude the chief difficulty that confronts us. Oxford and Cambridge are doing a work of the same nature as our undergraduate departments, and they are made up of colleges such as I am now discussing; but the bulk of their students are drawn from a single class in the community. Men of a different class who want that kind of education usually go to London, or to one of the provincial universities. This fact, together with the inducement of scholarships, and the tendency to be guided by inherited associations, causes the students to distribute themselves among the colleges in a very satisfactory way. The men who have grown up together as boys, or who come from the same region, do not collect unduly in one college. In America we should have quite a different result if we allowed the boy to select his group on first coming to the university. He would almost certainly go to the group or college where the men were that he knew already, or at least to a place where he would not feel too much of a stranger. The students would be mainly segregated on the basis of origin, of geographical sections, of preparatory schools, of home surroundings; and thus we should have—as people have said—a college for western men, a college for southern men, a

college for millionaires. Now this is the very worst scheme of divison that could possibly be devised. It would accentuate and intensify the unfortunate lines of cleavage in the student body that are now beginning to appear. It would stereotype and perpetuate them. It would erect barriers, to prevent a student from associating readily with the very men that he ought to be thrown with. What we need, on the contrary, is a system of grouping that will bring into each group men from different parts of the country, men with different experience, and as far as possible social condition. In short, what we want is a group of colleges each of which will be national and democratic, a microcosm of the whole university. This may not be an easy feat to accomplish, but I believe it can be done. Perhaps the freshman year, which is in any case a period of transition, could be advantageously used as a time for mixing the students together, and bringing out their natural sympathies and affinities before they make their final selection of a college. But whether this solution be adopted or not, the problem is one that is, or shortly will be, common to the leading endowed universities in the eastern states, and they must all solve it sooner or later in some way if they are to maintain their undergraduate departments, and make them of the highest value to the nation.

A. Lawrence Lowell
Harvard University

The Annual Meeting of the American Association of Museums

The second annual meeting of the American Association of Museums was held at the Carnegie Institute in the city of Pittsburg June 4–6, in pursuance of an invitation which had been extended to the association in May, 1906, by the trustees of that institution. The local committee of arrangements consisted of the trustees of the Carnegie Institute and a number of distinguished gentlemen representing various educational and commercial organizations in the city of Pittsburg, including the chancellor of the Western University of Pennsylvania, the president of the Chamber of Commerce, the president of the Pittsburg Stock Exchange and the presidents of the Academy of Science and Art of Pittsburg and the Botanical Society of Western Pennsylvania and the heads of various schools and colleges. An executive committee, presided over by Hon. James Macfarlane with Mr. C. C. Mellor as secretary, attended to all details.

Although the time fixed for the meeting unfortunately coincided with the commencement season in many institutions, and many members of the association were also compelled to be absent because already the work of exploration in distant regions had been begun by the museums which they represented, there were over sixty members of the association present, and almost all of the leading museums and art galleries of America were represented by one or more delegates.

The council convened in advance of the meeting of the association at the Hotel Schenley on the evening of June 3, and after dining, as the guests of Dr. Holland, the director of the Carnegie Museum, transacted the routine business which came before them in connection with the coming meeting.

The sessions were held in the lecture hall of science in the institute. President Hermon C. Bumpus, the director of the American Museum of Natural History, presided until the morning of Thursday, when the chair was taken by Dr. W. J. Holland, the second vice-president. Dr. George A. Dorsey was the secretary.

At the opening on the first day, June 4, at 10 A.M., an address of welcome was de-

livered by J. Rodgers McCreery, Esq., who took the place of his honor George W. Guthrie, Esq., the mayor of the city, whose business engagements prevented him from being present.

In the absence of W. N. Frew, Esq., the president of the board of trustees of the Carnegie Institute, who was prevented from being present by illness, Dr. Holland extended a cordial welcome to the association on behalf of the institute.

Dr. Hermon C. Bumpus gracefully responded in well-chosen words.

The remainder of the forenoon of June 4 was taken up with the transaction of routine business, the hearing of the reports of committees and the reading of a paper by Mr. Henry L. Ward, the director of the Milwaukee Public Museum, upon 'Museum Labels,' which led to a very interesting discussion. At 12:30 the association adjourned for luncheon, which was provided in the restaurant of the institute by the trustees.

From 1:30 until 2:30 the time was occupied in a tour of inspection of the new buildings of the institute, the various gentlemen on the entertainment committee and on the staff of the Carnegie Library, Art Gallery, and Museum acting as guides.

At 2:30 the reading of papers was resumed. Mr. Frank Collins Baker read a paper entitled 'Some Instructive Methods of Bird Installation,' which was illustrated by photographs. He was followed by Professor E. S. Morse, director of the Peabody Institute of Science, Salem, Mass., who presented a paper on 'A New Method of Mounting Ethnological Objects.' Dr. W. M. R. French, director of the Art Institute of Chicago, next addressed the association on 'The Advantages of Installation in Swinging Frames for the Exhibition of Textiles, Photographs, Prints and other Flat Objects.' A paper on 'The Exhibition of Large Groups in Museums,' by Professor Henry L. Ward, of Milwaukee, followed. Mr. P. M. Rea, director of the Charleston Museum, presented a paper on 'Museum Records.' All of these papers, which were admirably conceived and illustrated, led to pleasant and interesting discussions.

The association adjourned at 4:30 P.M., when the members were tendered an excursion by automobile through the parks and residential portions of the city of Pittsburg, a number of prominent gentlemen having kindly placed their automobiles at the service of the committee of entertainment.

At 8 o'clock the association reconvened. A symposium upon 'The Evolution and Aims of Museums of Art and Science' was opened by a paper by Mr. F. A. Lucas, curator-in-chief of the Brooklyn Institute of Arts and Sciences. He was followed by Mr. Benjamin Ives Gilman, the director of the Boston Museum of Fine Arts, who presented a scholarly paper on 'The Aims of Museums.' After the reading of these opening papers a general discussion in which all of those who were present were invited to participate took place.

Dr. George A. Dorsey, of the Field Museum; Dr. Henry L. Ward, director of the Milwaukee Public Museum; Professor E. S. Morse and many others spoke interestingly.

On June 5, at the opening session, a general discussion on 'The Present Jury System in Connection with Exhibitions of Contemporary Art' took place. The discussion was opened by Dr. W. M. R. French, director of the Art Institute of Chicago, who was followed by Dr. Charles M. Kurtz, director of the Albright Art Gallery of the Buffalo Fine Arts Academy. Mr. John W. Beatty, director of the department of fine arts of the Carnegie Insti-

tute; Mr. John Caldwell, who for ten years was chairman of the International Jury at the Carnegie Institute, and others spoke on the theme. Considerable diversity of opinion was expressed, and the debate, while lively, was thoroughly good-natured.

Following this discussion an interesting paper was presented by Mr. T. L. Comparette, the curator of the cabinet of coins in the United States Mint, Philadelphia, Pa., on 'The Installation and Exhibition of Coins.' Dr. Comparette was followed in his remarks by Dr. Kurtz and Dr. Holland.

At 11:30 the association adjourned and repaired to 'The Meadows,' the country seat of Mr. Robert C. Hall, at Ross Station, Pa., where they were treated to a barbecued ox with savory accompaniments. A brief session was held, at which the question of museum support was discussed and papers were read by Dr. W J McGee, director of the St. Louis Public Museum; Dr. George A. Dorsey and others. On the return, which took place at five o'clock, a visit was paid to the East Liberty branch of the Carnegie Library, under the guidance of Mr. Anderson H. Hopkins.

In view of the large number of papers to be read invitations to visit the Homestead Steel Works, the Allegheny Observatory and other interesting points were declined and the association resumed its sessions at 8 P.M. in the Carnegie Institute.

Election of officers for the ensuing year took place, resulting in the election of Dr. W. M. R. French (first vice-president) as president; of Dr. W. J. Holland (second vice-president) as first vice-president, and of Mr. F. A. Lucas as second vice-president. Mr. P. M. Rea, of Charleston, S. C., was elected secretary; Dr. W. P. Wilson, of Philadelphia, was reelected as treasurer; Dr Hermon C. Bumpus and Dr. George A. Dorsey were elected councilors for three years.

A very interesting paper, illustrated by photographs, was read by Miss Delia I. Griffin, director of the Fairbanks Museum of Natural History, St. Johnsbury, Vermont. Her theme was 'The Educational Work of a Small Museum.' She was followed by Miss Anna B. Gallup, curator of the Children's Museum of the Brooklyn Institute, who gave an interesting account of the work of the Children's Museum, illustrated with lantern slides.

On Thursday morning at nine o'clock the reading of papers was resumed. Dr. W. P. Wilson, of the Philadelphia Museums, gave a most interesting account of the work along educational lines of the great institution over which he presides, illustrated by examples of different collections which are prepared for the purpose of being loaned to the schools of the city of Philadelphia. He was followed by Mr. A. R. Crook, who presented a paper on 'The History of the Illinois State Museum of Natural History.' A paper by Mr. Edward K. Putnam, on 'The Educational Work of the Museum of the Davenport Academy of Sciences,' was read by title; a paper by Dr. Charles H. Hitchcock, curator of the Butterfield Museum of Dartmouth College, Hanover, N. H., on 'Ichnological Researches in Museums,' was likewise read by title in the absence of both authors. A scholarly paper, on 'Some of the Advantages of an Ecological Organization of a Natural History Museum,' was presented by Professor C. C. Adams, curator of the museum of the University of Cincinnati.

The association adjourned for luncheon at the Pittsburg Golf Club, where an excellent luncheon for all who were present had been provided.

The day being beautiful and sunny and

the skies clear, the stroll through the park to the golf club was greatly enjoyed by the members, many of whom visited the Phipps Conservatory on their way.

In connection with the postprandial exercises resolutions of thanks to the officers and trustees of the Carnegie Institute and the various generous citizens of Pittsburg who had provided for the comfort of the association were passed, and the association finally adjourned to meet in Chicago on May 5 as the guests of the Art Institute of Chicago, the Field Museum of Natural History and the Chicago Academy of Sciences, which united in tendering a joint invitation to the association to hold its next meeting in Chicago.

A committee on the publication of the 'Proceedings' of the meeting, consisting of Dr. W. J. Holland, Dr. George A. Dorsey and Professor P. M. Rea, was appointed. A full account of the meeting, together with the papers read will be issued.

The meeting is declared by all who were present to have been most enjoyable, and the American Association of Museums is undoubtedly firmly established as one of the national societies which is destined in coming years to exert a very beneficial influence upon the wide field of activities which is represented by the museums of art and of science in America.

SCIENTIFIC BOOKS

Clays; Their Occurrence, Properties, and Uses, with especial reference to those of the United States. By HEINRICH RIES, Ph.D., Assistant Professor of Economic Geology in Cornell University. Pages xvi and 490. New York: John Wiley & Sons; London: Chapman & Hall, Limited. 1906.

This comprehensive and well-balanced treatise on clays devotes the first five chapters, 276 pages, to the origin, the chemical and physical properties and kinds of clays, and to the methods of mining and manufacture. Chapters VI. and VII., 183 pages, describe the distribution of clays in the United States. The last chapter, of seven pages, is devoted to an account of the fullers' earth, including its properties, methods of mining and uses, and distribution in the United States.

In the special state descriptions the subject matter is set forth in the order of the geological formations as permitting the greatest uniformity of treatment, and as involving the least amount of repetition. In those states with which the present reviewer is most familiar, the descriptions are adequate and well presented, though necessarily in a concise manner.

For this part of the work the author is peculiarly well prepared from first-hand acquaintance, since he has personally examined and written reports on the clays for the geological surveys of a number of states, as well as for the United States Geological Survey. In these reports will naturally be found much of the matter of a general nature of the present treatise, since a general discussion of the origin, properties, and varieties of clays would be an appropriate and desirable introduction to the detailed description of their occurrences in the state reports, yet it must not be inferred that the general or introductory part of the volume before us is a mere compilation and repetition of the material already published in the several state reports by the author. As a matter of fact there is much in the introductory chapters and in the illustrations that has not appeared in any of these reports.

The clay resources of the different states are not equally well known, hence some inequality in the state descriptions, through no fault, however, of the author, because some of the important clay states, like Illinois for instance, have very little literature bearing on their clays.

In discussing the origin of clays the author emphasizes the facts that in the decomposition of feldspar, CO_2 is not an essential factor, since the mineral is decomposed by water alone; and that other feldspars besides orthoclase yield kaolinite. He also opposes the recently advanced view of Rösler that the

kaolinization of feldspar is never due to atmospheric action, but always to post-volcanic pneumatolytic and pneumato-hydatogenic processes.

> The very fact that many of our kaolins pass into undecomposed feldspar or feldspathic rock when the limit of weathering is reached, shows the incorrectness of such a broad statement (p. 7).

The discussion of the origin of clays is followed by a fairly complete description of the secondary changes both mechanical and chemical, in clay deposits, a feature often omitted in similar works.

In most treatises the statement is made that kaolinite is the basis of *all* clays, which are thus to be regarded as mixtures of kaolinite with other minerals. The incorrectness of this statement, the author thinks, will be made evident by an examination of any series of kaolin analyses, which will show that the alumina-silica ratio is often higher than that required for kaolinite, and this seems best accounted for on the supposition that some of the other clay-like minerals, such as pholerite or halloysite, are present. The fact is also pointed out that neither the chemical nor the rational analysis can in every case be relied upon to give certain information concerning the mineral composition and other characters of a clay. Thus, a washed kaolin might have as much as twenty per cent. of white mica, and yet on analysis show a composition approaching rather closely to that of kaolinite. And, moreover, kaolinite, pholerite, halloysite, and muscovite are all decomposed by hot sulphuric acid, and in a rational analysis would be reported as clay substance. This is unfortunate, since mica is not refractory and should not, therefore, be grouped with the other three (p. 167).

In Chapter II. the various minerals occurring in clay and their influence on its behavior, especially as regards shrinkage and fusibility, are quite fully treated. It has long been known that titanic oxide is of universal occurrence in clays, though seldom shown in analyses. Experiments of the author recently carried out with mixtures of kaolinite and titanic oxide up to 5 per cent., prove that even small amounts of this substance lower the refractoriness of clays, one half per cent. bringing the fusing point down half a cone. The importance of determining the titanium in a refractory clay is thus made clear.

Of the physical properties of clays, plasticity is in many respects the most important, and perhaps the most difficult to explain. The author considers the conception of plasticity as expressed by many as too narrow. He remarks:

> A broader conception, and probably a more satisfactory one to the physicist, would be to define plasticity as the property which many bodies possess of changing form under pressure, without rupturing, which form they retain when the pressure ceases, it being understood that the amount of pressure required, and the degree of deformation possible, will vary with the material (p. 94).

This definition would include many bodies besides clay, which are excluded by the narrower definitions.

The various theories put forward to explain the cause of plasticity are passed in review, with the conclusion that plasticity is not dependent upon any single cause advocated by these theories, but by a combination of them. The relations of texture to tensile strength are illustrated by experiments of Orton, Beyer and Williams, and the author, which go to show that in those clays having the highest tensile strength, the percentages of fine, medium, and coarse particles are nearly equal, and that an excess of either coarse or fine grains lowers the tensile strength.

In Chapter IV. the various kinds of clays, in the order of the purposes for which they are used, and beginning with the highest grades, are described as to their chemical and physical properties. These characters are further illustrated by typical physical tests and chemical analyses. The latter part of this chapter, devoted to descriptions of methods of mining and manufacture, might by some be criticized for lack of sufficient detail, but the book is not intended to be a treatise on the manufacture of clay products alone, and too much technological detail would be clearly out of place.

The illustrations are well selected, not for

ornamental purposes, but for the real illustration of the text. The book is well printed and bound and with no undue share of typographical errors.

While the different topics discussed in this work have been treated in more or less detail in official reports and in special articles, Dr. Ries's book will be welcomed by all interested in the subject of clays, as being certainly the most comprehensive and evenly balanced, if not the only, presentation of the subject as a whole that we have. And though written primarily for American geologists, chemists, and engineers, the introductory part, being of a general nature, should be equally useful to men of all nationalities.

EUGENE A. SMITH
UNIVERSITY OF ALABAMA

Biochemie der Pflanzen. Bd. II. By FRIEDRICH CZAPEK, Ph.D., M.D. Gustav Fischer in Jena. 1905. Pp. xii + 1027.

The second volume of this important work on the chemistry of plants has fully sustained the high expectations excited by the first volume. In something over a thousand pages, the author brings his account down to the state of our knowledge as it existed in June, 1905. It is impossible in the space available for this purpose to give more than a most meager outline of the contents of this volume of this truly great work. A general discussion of the biochemistry of plant albuminoids is followed by a treatment in some detail of the phenomena connected with this class of bodies as seen in the physiological processes of various groups of plants from bacteria to phanerogams, and as seen in the various organs and structures of these plants.

The second large division deals with the nitrogen-containing end products of plant metabolism. The discussion is one of rare interest, especially as dealing with the chemical physiology of hydrocyanic acid and with the plant alkaloids. We have had chemical discussions and botanical discussions on these subjects, but the author has here succeeded in making the facts of either category illuminate those of the other, an observation that applies to a remarkable degree to all parts of the book.

The chapters on the physiology and chemistry of the relation of plants and plant products to oxygen is succeeded by a treatment of the part played by ash constituents in plant metabolism in its widest relations. A chapter of unusual interest on the chemical aspects of plant irritability concludes the body of the work.

It would be hard to speak in too high praise of this work. It comes into a place in botanical literature that has never been filled heretofore, and as the drift of plant study in recent years has been strongly in this direction, the need of such a work has been more and more keenly felt. This book will go on to the same shelf of indispensables on which Pfeffer's 'Physiology,' Goebel's 'Organography' and Haberlandt's 'Anatomy' are to be found.

It is to be strongly hoped that the author may find opportunity from time to time to revise the work as the progress of science makes necessary, and thus provide investigators with a ready means of keeping in close touch with the progress of physiology. The author gives evidence of a desire to do this by providing in an appendix references to literature appearing after the body of the work was completed.

This book should be translated into English, and that at an early date.

R. H. TRUE

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for May opens with an article by Herbert W. Rand on 'The Functions of the Spiracle of the Skate,' the conclusion being that it serves chiefly as an in-take for the respiratory stream, and that the reversal of the stream, or spouting, may serve to clear out the gill chambers and be analogous to taking a deep breath. F. H. Pike presents 'A Critical and Statistical Study of the Determination of Sex, Particularly in Human Offspring.' Among the conclusions are that in man there is a slight excess in the number of male offspring; that sex determination probably occurs before the fertilization of the ovum and that sex is

hereditary. Alfred W. G. Wilson gives some interesting accounts of 'Chubs Nests,' probably made by *Semotilus corporalis*. These 'nests' are small mounds of pebbles and sometimes reach a diameter of five or six feet and a height of 14 to 24 inches. In correspondence Dr. Jordan alludes to the flying-fish problem, stating his opinion that the fins are *not* moved. But when a flying-fish is laid on a vessel's deck the fins are flapped vigorously, and why not in the air?

The Museums Journal of Great Britain for April notes that the eighteenth meeting will be held in Dundee. F. A. Bather discusses 'Interchangeability in Cases,' with special reference to those in the geological department of the British Museum. It is soothing to find that Dr. Bather has met the ever-occurring irritating facts that the cabinet-maker shows a diabolical ingenuity in frustrating the work of the designer, and that no carpenter with any proper pride will make a drawer or a shelf that will run freely. The interchangeability of large cases is rather a difficult matter, but was to a great extent applied by Dr. Goode in the U. S. National Museum. Dr. O. Lehmann describes some interesting features in 'The Altona Museum Exhibit at Dresden, 1906,' wherein he so arranged the specimens as to give the visitor the idea that nature works in much the same manner as the artist and that the form is the shortest artistic expression of the whole life of the animal. From this and previous articles it is evident that Dr. Lehmann has expended much thought in making his museum attractive and instructive to the ordinary visitor.

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES—SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY

A JOINT meeting with the Physics Club of New York City was held at the American Museum of Natural History on Friday evening, March 22. The following demonstrations were given:

F. J. ARNOLD: Finding the weight of an irregular body by means of its center of gravity. An irregular body consisting of a 50 cm. wooden rod with a bar of metal attached at one end to give the combination a low center of gravity. Location of center of gravity, fulcrum and known force marked on paper strip fastened to bar and lever arms measured directly by means of these points.

R. H. CORNISH: (1) Method of projection on screen of lines of force surrounding a conductor carrying a current. (2) Mechanical illustration of beats in sound.

J. STEWART GIBSON: New piece of apparatus for showing the relation between intensity of illumination and distance.

W. R. PYLE: (*a*) Dip-needle demonstration. (*b*) Magnetizer for magnets.

E. R. VON NARDROFF: An apparatus for determining the moment of inertia in gm.-cm.^{2} units.

CHAS. FORBES: (*a*) The osmosescope. (*b*) The centrifugal railway.

W. M. Campbell read a paper on the effect of pressure on magnetization of iron. The paper referred briefly to the Kirchoff theory on the effects of stress deduced from the strains due to magnetization, to the experimental work done by Wassmuth, Tomlinson, Nagaoka and Honda and Miss Frisbie, and the contradictory results they obtained. Then followed a description of the apparatus used by the writer, the method of conducting the experiment and the results. Higher pressures were used in magnetizing fields stronger than those used by other investigators. Keeping the pressure constant and changing the field, the results showed an increase in intensity up to about eighteen units of field, then a decrease with a change of sign at about $H = 90$ units, and a continual decrease with increase of field.

J. Stewart Gibson read a paper on the results of a series of experiments on the critical angle; its effect on vision from underneath the surface of water.

At a meeting of the section held on Monday evening, May 20, F. M. Pedersen read a paper on the influence of molecular structure upon the internal friction of the vapors of certain isomeric ethers. The viscosity coefficients of

various ether vapors at 100° C. were obtained by the well-known transpiration method. In the apparatus used the capillary was perfectly straight and the driving pressure obtained by a column of mercury descending under gravity. The most interesting substances examined were eight ethers, some of them extremely rare, divided into three groups of isomers. The results show the same fact for these propyl compounds that was observed by Lothar Meyer[1] and Steudel for butyl compounds, viz., the molecules of a tertiary compound are smaller than those of a secondary, which in turn are smaller than those of a primary.

William Campbell read a paper on the iron carbon series of alloys. The various published equilibrium curves of the series, by Roberts-Austen, Rooseboom, Le Chatelier, Benedicks and others, were reviewed. A series of lantern slides showed the various changes of structure which take place (*a*) by variation in composition; (*b*) by annealing at different temperatures. Two systems were shown to occur: I. austenite (mixed crystals) and cementite; II. austenite and graphite. The former is unstable, the latter stable.

WILLIAM CAMPBELL,
Secretary

COLUMBIA UNIVERSITY

[1] *Pogg. Ann.*, 1882, Vol. 16, p. 394.

DISCUSSION AND CORRESPONDENCE

THE CLOCK OF THE U. S. NAVAL OBSERVATORY

TO THE EDITOR OF SCIENCE: While not desiring to appear to enter into any controversy with the author of the article on 'The Clocks of the Greenwich and the U. S. Naval Observatories' which appeared in your issue of May 31, it would seem that certain facts should be stated to clear up the misunderstanding that has occurred.

I think no one will disagree with the statement that the value of an astronomical clock is to be measured by the degree of accuracy with which its correction can be predicted from observed corrections or interpolated between those corrections: If a series of clock rates extending over several months can be shown to follow such a simple law as that given on page 451 of SCIENCE for March 22, 1907, for the Naval Observatory clock, *viz.*:

$$\text{Daily rate} = +0^s.0161 - 0^s.00103\,(T - \text{Mar. } 29.0) - 0^s.0456\,(t - 27°.0),$$

and when both these terms have such a probable explanation in physical phenomena, it would be folly to refrain from the use of this formula in investigating the running of the clock. It follows that the mean residual $0^s.015$ is what really indicates the performance of the clock and not $0^s.035$ as deduced by Mr. Lewis.

The statement by Mr. Lewis that in my article "the Greenwich clock rates are spread over a period of one year" is somewhat misleading as they were divided into twelve monthly groups and each group was considered by itself as is clearly shown on page 450 of SCIENCE for March 22, 1907. That would seem to be as fair a method of treating them as the published data would provide.

In conclusion attention may be called to the article in SCIENCE for April 12, 1907, page 570, 'A Riefler Clock and a Self-registering Right Ascension Micrometer,' in which it has seemed to the writer that the Naval Observatory clock runs even better than was indicated by the mean residual $0^s.015$.

W. S. EICHELBERGER
U. S. NAVAL OBSERVATORY

VARIATION IN THE COROLLA OF LINARIA VULGARIS MILL

TO THE EDITOR OF SCIENCE: In examining the *Linaria vulgaris* Mill., with a class in botany I found the following remarkable variations in the corolla which may be of interest to some of your readers. The flowers in which the variations appeared were all on the one specimen.

In the corolla of two of the flowers in which the variations occurred the spur was absent, as was also the usual orange-colored palate. The corolla in both these flowers consisted of five petals, but in one case there were four petals in the upper lip and one in the lower, while in the other all five petals were in the position usually occupied by the upper lip.

The corolla of a third flower was tubular,

about three fourths of an inch long, of greatest diameter at the base and tapering to the apex. At the base of this peculiarly formed corolla there were three spurs about one third of the circumference of the corolla apart. The apex of the corolla terminated in a circular crown, which was orange-colored, like the palate in the ordinary flower. At the upper end of the tubular corolla, close to the orange-colored crown, there were three petal-like tips equally distant from one another.

J. B. Turner

THE INDIAN BEDBUG AND THE KALA AZAR DISEASE

It is not generally known by the entomologists of this country that the common bedbug of India is not *Cimex lectularius* Linnæus, but *Cimex rotundatus* Signoret (= *macrocephalus* Fieber). Captain W. S. Patton, of the Indian Medical Service, has recently published important papers on this insect, especially in regard to its pathogenic relations. In a brief note on the distribution of these two house-infesting bedbugs published in the *Indian Medical Gazette,* XLII., February, 1907, he points out the above-mentioned fact, and leads us to form the opinion that enough observations have not been made along that line. *Lectularius* is apparently distributed mainly throughout the North Temperate Zone, while *rotundatus* is tropical or subtropical; and though until very recently known from Burma only, it is now recorded by Dr. Patton as occurring throughout India, Assam, Malay, Aden, Mauritius and Réunion (Patton, *ibid.*) and still more recently (Patton, April 4, 1907, *in litt.*) it is recorded from St. Vincent, Sierra Leone and Porto Rico. I have specimens from Madras Presidency (South India), Réunion, Mauritius and St. Vincent, kindly sent by Dr. Patton.

These facts in regard to the distribution of the Indian bedbug become of economic importance in view of the now definite evidence which Patton presents that the dreaded kala azar disease of India is carried by that insect. This evidence is published as No. 27, new series, *Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India,* Calcutta, 1907, and is entitled 'Preliminary Report on the Development of the Leishman-Donovan Body in the Bedbug.' By the means of extensive experiments with bedbugs, it is fully demonstrated that these bodies, the cause of the disease, are ingested from patients and go through considerable development. In a postscript to this paper, Patton states that all of the intermediate stages of development and fully developed flagellates have since been found in the insect, and he states his belief that 'it is beyond all doubt that this insect transmits the disease.' Owing to conditions, it is impossible for him to test this directly by exposing healthy persons to the attack of infected bedbugs, but as it is, the evidence is complete and all of the facts point to the conclusion reached by Dr. Patton.

The establishment of this relation of the Indian bedbug to the transmission of a much-dreaded disease naturally directs our attention again to the pathogenic relations of our own common household pest, *Cimex lectularius* Linnæus, which is now under investigation by some of the medical profession.

A. Arsène Girault

Washington, D. C.,
May 25, 1907

SPECIAL ARTICLES

THE SOLENODON OF SAN DOMINGO: ITS EXTERNAL CHARACTERS AND HABITS

A specimen of this rare and curious insectivorous mammal (*Solenodon paradoxus*) recently obtained by Mr. A. Hyatt Verrill in San Domingo and preserved in formol, has been submitted to me for study. Owing to the introduction of the mongoose and other causes this creature has become very rare and local. It is, without doubt, on the verge of extinction. At present, it is scarcely known in the great museums of Europe, and no specimen is known to be preserved in any American museum. A single skeleton is said to exist in the museum of Berlin. The only other *Solenodon* (*S. cubanus*), of eastern Cuba, is said to be nearly or quite extinct. It is a smaller and more hairy species, with shorter tail

The San Domingo specimen is about 14 inches long, to base of tail; the tail is 13 inches long, round and scaly, like that of a rat. The long, tapered, flexible snout is naked and pinkish white. The body is mostly covered with long, coarse, brown hair, which becomes finer and light yellowish brown or tawny on the head, shoulders and neck. The hind quarters and thighs are partly naked and covered with rough, wart-like excrescences and irregular coarse wrinkles. The fore legs are strong, with large stout claws, which are less curved than in the Cuban species.

It is nocturnal in its habits, living by day in the deep holes and crevices of the cavernous limestone. It feeds, in the wild state, largely on insects and their larvæ, tearing old logs and stumps in pieces to obtain them. But it will also eat the eggs and young of birds, as well as various fruits, and sometimes it is destructive to young poultry, it is said. In confinement it is almost omnivorous and will eat meat freely. This specimen is a female. It gave birth to three naked young ones soon after its capture, but very soon devoured them. It is said to be very stupid when pursued by dogs.

A. E. VERRILL

A NOTE ON THE HAMMERHEAD SHARK (SPHYRNA ZYGÆNA) AND ITS FOOD

DURING the third week in July, 1906, several large sharks were seen, at high water, in various parts of the harbor of Beaufort, N. C. On the twentieth Captain Ed. Robinson, of the sharpie *Gladys,* harpooned one which was chasing large sting-rays (*Dasyatis say* is the form most common at Beaufort) over some sand flats. The harpoon tore out, but, when the fish came up again, another throw was more successful and the shark, which proved to be a hammerhead, was secured. Practically all those who have recorded the capture of hammerheads have noted that when hooked they made violent efforts to escape. This one, when harpooned, made so little resistance that Captain Robinson in describing its capture expressed considerable disappointment at the tameness of the affair. This capture was made in a narrow channel within two hundred yards of the wharves of the business part of Beaufort. Eighteen hours later I secured the fish, towed it over to the laboratory wharf and swung it up by a block and tackle to a davit, where it was photographed, measured and dissected.

This was the largest shark ever captured in Beaufort Harbor, and it was carefully measured. Thinking that these measurements may be of interest and value, I give the most important. Length all over, 12 ft. 6 in.; length of 'hammer' between eyes, 3 ft.; girth at first gill-slit, 4 ft. 2 in.; girth in front of pectorals, 4 ft. 2 in.; in front of pelvics, 4 ft. 1 in.; at root of caudal, 1 ft. 6 in.; length of right pectoral fin, 2 ft. 1 in.; of dorsal, 2 ft. 6 in.; of right pelvic, 1 ft. 1 in.; of second dorsal, 10 in.; of ventral lobe of caudal, 1 ft. 7 in.; of dorsal lobe of caudal, 3 ft. 6 in. There being no means at hand for weighing the animal, estimates only could be made, but, judging by the number of men required to hoist it with a tackle having three pulleys, it must have weighed at least 800–1,000 pounds.

This shark was a female and was dissected with the hope that embryos might be found in the uteri, but all the generative organs were practically unrecognizable. This was due to the stones thrown down the gullet by boys while it was hanging overboard the sharpie (the head being above water), and to the churning brought about by the movements of the tide and by its being successively hauled up for people to inspect and let go into the water again. The posterior cardinal sinuses were in good condition and were as large as a man's thigh. Their walls were cavernous by virtue of the extraordinary development of the tendinous prolongations of the lining membrane.

The stomach contained, in addition to the stones above mentioned, an almost perfect skeleton of a fair-sized sting-ray together with many cartilaginous fragments plainly having the same origin. However the most interesting thing found in the beast was the great number of sting-ray (*Dasyatis say?*) stings present in the body and mouth. In the process of skinning the fish, several were found in the neck region and in the back. However, in cutting out the jaws for a museum specimen,

I found the mouth parts to be a perfect mine of stings. In all fifty were extracted, more than forty of which were imbedded in the flesh adherent to the jaw cartilages. These stings varied in size from perfect specimens four or five inches in length to broken-off tips hardly more than one inch long. These broken-off stings were especially abundant at the angles of the jaws where as many as three or four tips were frequently found in a cube of flesh one inch square and two inches long. One can only conjecture how many could have been found by a careful dissection of the flesh of the mouth and throat. The dissection of the jaws was not gotten at until about forty hours after the capture of the shark and its condition consequently was such as to prevent the minute dissection necessary to extract all the spines in the throat region. The lower jaw cartilages were scarred and ridged from angle to symphysis, evidently by stings received in former combats. Some of the stings were manifestly but newly implanted, for the flesh around them was still red from congested blood, in other cases the redness had all disappeared, while some of the stings were plainly old, being imbedded in cysts. Especially was this latter condition true of those piercing the membrane surrounding the cartilages.

Not knowing that anything has been discovered as to the especial food of the hammerhead shark, I wish to advance the suggestion that this is to a certain degree made up of its not far distant kinsman, the sting-ray. This suggestion is based on three facts. First, that this shark was chasing sting-rays when harpooned, and was so eager in the chase that, when the first 'iron' pulled out, it kept up the chase in the neighborhood of the boat until harpooned a second time. Secondly, on the finding of the skeletal remains of rays in its stomach. The whole skeleton of a long-tailed ray found there seems to prove that the remains were not those of the butterfly ray (*Pteroplatea maclura*), which is abundant at Beaufort, but of *Dasyatis say*, the most common armed form. Thirdly, the very large number of stings found in and around the mouth parts indicates the number of rays which this shark caught and which had been successful in stinging it.

Since writing the above paragraph, my attention has been called by Dr. Theodore Gill to a note by Dr. Edwin Linton in which the latter states that from dissections of fifteen small specimens of another species of the same genus of shark, *Sphyrna tiburo*, at Beaufort, he found that the food consisted chiefly of Crustacea—blue crabs, *Mantis* and other shrimps, and acorn barnacles—of seaweed, and of pieces of fish used for bait; but not of whole fish such as they might be expected to prey upon.[1]

E. W. Gudger

State Normal College,
Greensboro, N. C.,
January 24, 1907

Do Offspring Inherit Equally From Each Parent?

The alleged fact that offspring inherit equally from each parent, together with the striking parity, in number, size and form, between the chromosomes of the mature male and female germ cells, notwithstanding the great disproportion in size between the egg and the spermatozoon themselves, is frequently advanced as one of the strongest supports of the chromosome theory of inheritance.

But do we inherit equally from each parent? What seems obvious at first glance becomes very doubtful upon closer inspection. The vast majority of the characters of a given organism, such, for example, as make it an animal and a vertebrate of a given genus and species, are obviously characters which are common to both parents. The only characters which we can measure are the minor ones of individual or specific peculiarity, and while these, apparently, may be derived equally from either parent, this conclusion is very different from one which would affirm that the qualities of the offspring as a whole are derived equally from each parent. The hybridist can

[1] These observations were made while I was acting as a temporary assistant in the Fisheries Laboratory at Beaufort. For permission to publish them here, I wish to thank the Commissioner, Hon. George M. Bowers.

help us little here, because his so-called 'unit characters' are only these same superficial individual and specific qualities, and the fact that the crossing of any but comparatively closely related forms is impossible, precludes any final solution along this line.

The facts at our command, indeed, indicate that the female germ cell determines the fundamental animal form together with its more constant characters. Driesch, for example, found that in hybrid echinoderms, no matter from what species the sperm were taken, the manner and rate of cleavage, the character of the mesenchyme formation and of gastrulation always followed the *maternal* type. Standfuss has shown that young butterfly hybrids first resemble the maternal species, but diverge more and more towards the male species with each metamorphosis, as individual qualities begin to assert themselves, until the hybrid comes to its ultimate degree of intermediacy.

If we accept the idea of 'formative substances' as advanced by Conklin or Lillie, whether we regard these substances as really specific organ-forming materials or as indicating corresponding cytoplasmic localizations, then the fundamental organology is already laid down in the egg before the spermatozoon enters, and the egg passes on to cleavage without waiting for an equal amount of 'formative substance' to pass out from the male pronucleus and take joint possession of the already localized areas. For example, Lillie[1] states that at fertilization the presence of the sperm involves no important changes in the topography of the several formative substances which are distributed throughout the cytoplasm of the egg. Since, then, there is no evidence of such a biparental mechanism in early stages, is it not decidedly far fetched to postulate one, especially when the single one that already exists is adequate?

If it is true that offspring do not inherit equally from each, but more from the maternal parent, then the argument for the morphogenetic nature of chromatin based upon the striking parity between the chromosomes of male and female germ cells after reduction loses its force, if we still cling to the idea that the chromosomes are the *exclusive* bearers of hereditary qualities.

Contrary to the view that fertilization is primarily concerned with the mingling of hereditary qualities, many zoologists have come to regard it as satisfying some periodic physiological need of the organism, and while one conception is perhaps as hazy as the other, still the latter opens up an equal possibility that the reduction divisions have to do with maintaining a metabolic equilibrium of some kind, instead of acting as a mechanism for the casting out of heritable morphological units.

But granted that the chromosomes are the bearers of specific morphogenetic substances, even then the facts (1) that there is apparently a persistence of the individuality of the chromosomes through successive cell-generations, and (2) that the final behavior of the chromosomes in reduction division is in seeming accordance with the demand of the Mendelian principles—even these facts do not necessarily restrict us to a purely chromosomal hypothesis of heredity nor to the idea that offspring inherit equally from each parent. However, since this is one of the most significant lines of argument for this hypothesis, it merits more detailed discussion.

Various hybridists, judging from the external visible characters of hybrids, came to the conclusion that in the germ cells of hybrids there must be a separation of parental qualities so that with respect to a given quality, half of the germ cells returned to the maternal, half to the paternal types. Conversely, I had in the meantime, from studying the germ cells of hybrid doves and pigeons, called attention to the fact that there is apparently a segregation of maternal and paternal chromosomes at the reduction period which, if the chromosomes bore hereditary qualities, would lead to the establishment of pure germ cells, and thus afford a possible explanation of how the offspring of hybrids come to show returns to grandparent types.[2]

[1] *Jour. of Exp. Zool.*, III., 2, p. 178.

[2] SCIENCE, February 16, 1900.

However, I had previously noted and recorded[3] this fact of the reversion of the offspring of hybrids to the grandparent types.

Later Montgomery (1901) and Sutton (1902), working on non-hybrid forms, which have chromosomes of varying size, presented striking evidence of the fact that in early germ cells there are pairs of homologous chromosomes, one of paternal and one of maternal origin, and that these homologous chromosomes unite in synapsis. The ensuing reduction division simply brings about their separation and segregation in different cells.

Although I had elaborated the idea of the relation between the chromosomal phenomena of hybrids and the reversion of their progeny, in my doctoral thesis of 1900, the published statement of the details did not come out until November, 1902,[4] but these details show that I had hit upon practically the Mendelian idea. Very soon after the appearance of my paper in 1902, Cannon, Wilson and Sutton published conclusions of a very similar nature, endeavoring to offer a cytological interpretation of the Mendelian principles, which had had their renaissance in the meantime. Only Cannon's conclusions, however, were based upon the actual study of hybrid material. In this way it became established that there is a mechanism in germ cells which, assuming that the chromosomes are concerned in heredity, could possibly lead to a segregation of paternal and maternal qualities.

But if we accept the idea of Boveri and of Sutton that each chromosome contains only a certain pro rata of adult characters, and that reduction is simply the separation of homologous mates, then besides facing the unproven though necessary implication that whole blocks of grandparental characters are barred from the third generation, we must also recognize, as pointed out by Davenport and others, that this theory is not in harmony with certain facts of non-alternative (non-Mendelian) inheritance. How, for example, are we to account for the well-authenticated instances of (1) blended inheritance, (2) of pronounced atavism, such as is seen in mongrelized breeds of pigeons, which tend to return to the primitive ancestral blue-rock type with apparently none of the components missing, (3) of exclusive inheritance or prepotency, (4) of the later outcropping of dominant characters in a recessive individual, which has sprung from a gamete that, according to this chromosomal theory, has been purged of such dominants, or, in other words, the contamination of a given character by its allelomorph, and (5) of the 'fixation' of a hybrid mosaic gamete, of which the qualities do not segregate in subsequent generations?

Even though we have visible evidence of the separation of homologous chromosomes, I fail to see why this necessarily means that each has retained all of its original qualities, or has taken on no new ones. It is easily possible that there can be persistence of form in these chromosomes without persistence of qualities. Supposing that the chromosomes differ from one another in their physical properties (and they doubtless do, more or less, since we can recognize constant types), the form might easily be dependent upon the physical consistency of each of the particular chromosomes, which, in fact, is made up of at least two substances, viz., chromatin and linin. It is evident that in pro-synaptic stages when the chromosomes are characteristically present as hazy granular masses, numerous conjugations or exchanges of individual granules could occur, and yet the matrix (linin) bearing the qualities, persist and appear finally in its characteristic form.

In my own study on the spermatogenesis of hybrids, I was finally led to consider the strict individuality of the chromosome as persisting only in hybrids derived from widely divergent forms. In the case of fertile hybrids my idea was expressed as follows: "The cases in which the entire plasmas are segregated are then probably but magnified images of what occurs among the specific qualities of the milder crosses."[5] Furthermore, I have suggested that the occasional inequalities in the divisions of individual chromosomes might

[3] *Zoological Bulletin*, Vol. II., No. 5, 1899.

[4] 'Hybridism and the Germ-cell,' *University of Cincinnati Bulletin*, No. 21, November, 1902.

[5] *Cincinnati Lancet-Clinic*, May 9, 1903.

account, in part at least, for the fact that all germ cells are not absolutely pure in hybrids, and it may be thus that in cases of apparently complete return to one parent type, characteristics of the other parent may, nevertheless, crop out from time to time in succeeding generations.[6]

In the foregoing attempt to reconcile the behavior of chromosomes with the Mendelian principles it is clearly assumed that the chromosomes are the mechanism, or at least the chief mechanism of heredity. But turn them and juggle them as we may, we see that it is difficult to make the conclusions of the cytologist who clings to an exclusively chromosomal theory fit into the facts of heredity, and the difficulty becomes all the greater if it is true that the male and the female do not contribute equally in heredity. The latter difficulty, together with an attempt to explain reversions, led me to the suggestion, in a former paper, that both cytoplasm and nucleus are involved specifically in inheritance, the cytoplasm of the germ cell representing the more stable and constant form of the animal, and the chromatin the more individual and variable characteristics. If the male contributes chiefly individual qualities, and if we accept these as being borne in the chromosomes, then since these chromosomes are so strikingly paralleled by those of the female in both number and form, we might infer that the chromosomes of the female likewise bear only individual and variable qualities, while the cytoplasm bears the fundamental qualities.

The material starting points (or *inceptors*) of definite characters were conceived of as arising through the activity of chromosomal emanations on cytoplasmic materials at different stages in the development of the organism. Since the chromatin was looked upon as the more variable cell constituent, it, rather than the cytoplasm, was regarded as conditioning the more variable characteristics, without, however, precluding some nuclear activity at all stages of development. There is every reason to believe that both cytoplasm and nucleus in a given species are *distinctive* of that species and there is no conceivable reason why the cytoplasm any more than the nucleus must be made so anew in each generation. The variable nature of chromosomes is evidenced in the pronounced irregularities which are induced in them through hybridizing or drugging. Furthermore, the intimate mingling of the chromatin from the two sexes, the known fact that definite substances (enzymes, etc.) emanate from the nucleus, and the highly unstable nature of nucleo-proteids, would point to the chromosomes as, at least, an adequate source of variability. Lastly, the facts of differentiation, before fertilization, etc., mentioned above, seem to indicate that offspring do not inherit all characters equally from parents but rather only the more superficial ones, and that, therefore, chromosomes, which are derived equally from each parent, are connected in some way with such superficial characters.

Furthermore, such an interpretation would harmonize better with the fact that the numerical variation of chromosomes in closely related groups may be out of all proportion to the character differences of the groups. For example, Miss McGill, working on *Anax,* has found 28 chromosomes, while in some recent studies on a *Libellula* I find 23 or at most not over 24 chromosomes. How, then, on the exclusively chromosomal hypothesis of heredity, are we to account for the discrepancy in the number of chromosomes, such as exists between two members of so restricted a group as the Odonata, which, despite their individual differences, must have the vast majority of their fundamental features in common? Or how account for the pronounced numerical differences in chromosomes as recorded by Wilson in different genera of the Heteroptera. For example, *Anasa tristis* has 21 in the male and 22 in the female, while *Protenor belfragei,* or *Alydus pilosulus,* has 13 in the male and 14 in the female. Even related species of the same genus may differ in the number of chromosomes, and there are indications that this may be true of different individuals of the same species. The numerical differences would

[6] See 'Spermatogenesis of Normal and of Hybrid Pigeons,' p. 48.

seem to be out of all proportion to the actual differences between the adult genera or species.

The facts would seem to force us, if we still cling to the idea that in chromosomes we are to find specific morphogenic substances, to some such postulate as the one already suggested, that only the more superficial and fluctuating qualities are borne in the chromosomes, for then we might appreciate how considerable fluctuation in the number of chromosomes in different species might be reconcilable with the relatively smaller differences between the adults.

However, this idea of the respective rôles of cytoplasm and nucleus in inheritance was offered only as a suggestion, and not as a theory and such it must remain, unless some more convincing evidence is forthcoming. Its only value in this connection is to show that we are not restricted to a consideration of the chromosomes as the sole vehicle of heredity, and that equality in the amount of chromatin contributed by each parent, even should we succeed in assigning heritable qualities to the chromosomes, does not necessarily imply that we inherit equally from each parent.

Michael F. Guyer
University of Cincinnati,
March 12, 1907

Thrusts and Recumbent Folds, a Suggestion Bearing on Alpine Structure [1]

Let it be assumed that as a result of a shearing strain a thrust fault, *A*, is initiated in the crystalline basement of a sedimentary series, and that displacement occurs along a plane which rises at a gentle angle to the plane of stratification. Let it be assumed further that the strata comprise a soft shale overlain by a limestone of moderate thickness, above which is a thick series of sediments.

The immediate effect on the shale will be to thicken it in front of the overthrust crystallines (as was repeatedly observed in the case of soft layers under similar conditions of pressure in experiments on folding described in the Thirteenth Annual Report of the U. S. Geological Survey). In swelling the shale

[1] Read before the Geological Society of Washington, April 10, 1907.

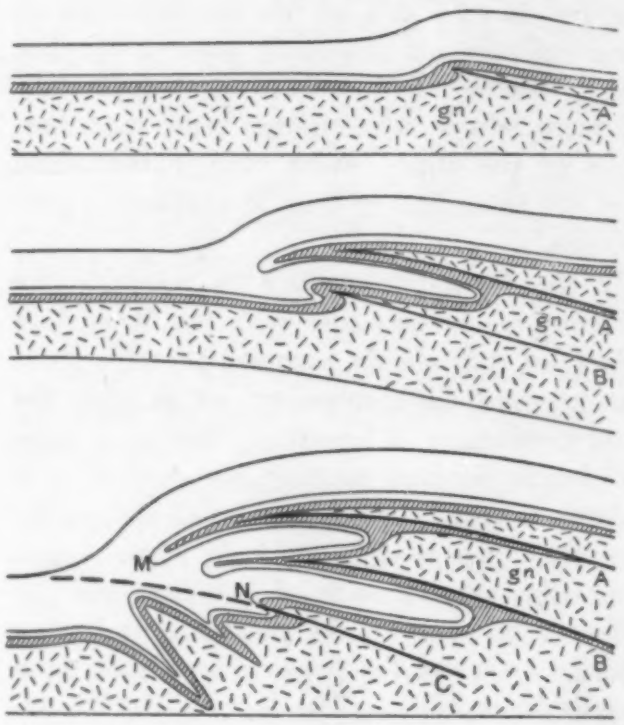

Fig. 1. Hypothetical Development of Recumbent Folds from Overthrust Faults.

will have somewhat the effect of a laccolithic intrusion and will raise the overlying limestone, forming an anticline.

If the plane of the thrust forms an acute angle with that of the bedding, the shear may follow the bed of shale, thus separating the limestone and overlying strata from the underlying; and the stress transmitted by the advancing tongue of gneiss to the limestone may roll the latter back upon itself. The overlying strata would become more or less involved in the overfold.

The recumbent fold will develop to a length determined (1) by the competency of the strata to transmit thrust; (2) by the effect of the resistance, which increases as the strata pile up; and (3) by the conditions favoring the development of a second thrust fault, *B*.

If the movement continues to the production of a second thrust, *B*, the plane of the thrust, *A*, and the recumbent beds will be raised into an anticlinal attitude, as the flat strata were in the first instance. Thus the point of the overturn, *M*, will appear to be bent downward, and if movement continues on the thrust, *A*, it may become bent under. Such movement could not, however, continue

far, before the thrust, *B*, would take up all the stress.

There is no obvious reason to limit the development of the schuppenstruktur, *A* and *B*, to two thrusts. A third and possibly a fourth might be produced. It might, however, occur that the accumulated thickness of piled-up strata should become so great, or the conditions of slight resistance in the plane of shear so favorable to displacement, that the whole recumbent mass would move forward upon a great major thrust, *C*, to an indefinite distance.

It is apparent on inspection of the diagrams that the length of the strata involved in the recumbent folds between *M* and *N* bears a relation to the total displacement on the overthrusts. The two are not equal, for the strata in the overturned limbs of the recumbent folds are stretched; but the two lengths may be said to be of the same order of magnitude.

The preceding hypothetical relations of recumbent folds to overthrusts were developed from a study of the extraordinary recumbent folds of Mont Joly as described by Ritter.[2] It followed from measurement of Ritter's sections that the length of strata involved in the recumbent folds was about 130 kilometers, whereas that included in the supposed roots was but 16 kilometers. If the folds and roots bear the relations attributed to them the lengths of the strata when developed should be at least of the same order of magnitude. The further analysis of the problem led to the conclusion that the recumbent folds represent a sequence of thrusts, as described above. The probable total displacement on thrust planes might be as much as 80 kilometers. The present position of the thrust planes would be above the Alps, or in the alpine summits, on the assumption that they have been raised during later elevation of the range. Their extent would carry them over the range to the southern slope.

At first sight this conclusion appears to accord closely with the phenomenal nappes des recouvrement of Lugeon, but there is a distinction. Whereas the nappes are supposed to have been projected over the Alps at their present elevation, the thrusts are believed to have developed in a shear zone beneath the surface, before the Alps were the visible mountains of to-day, and to have risen from a considerable depth toward the surface, as is the habit of thrusts. On independent evidence the date of thrusting is assigned to a pre-Eocene (pre-Flysch) date. The elevation which has raised the fully developed, one might say exhausted and dissected, thrust planes to the height of the summits of the Alps is, on the other hand, assigned to the middle Tertiary epoch of diastrophism, which also caused folding and the more obvious overthrusting.

BAILEY WILLIS
U. S. GEOLOGICAL SURVEY

[2] 'La bordure sud-ouest du Mont Blanc,' Bull. des Serv. de la carte de la France, No. 60, profile I., Plate I.

QUOTATIONS

TEACHERS' SALARIES AND MINNESOTA

THERE has been recently among the alumni in various eastern colleges and universities, notably of Harvard and Princeton, a movement to secure funds to advance the salaries of instructors. The movement has appealed with some success to the loyalty of alumni and the benevolence of interested friends. A similar movement was actively started among the alumni of the University of Minnesota last fall, with the result that the regents of the university now have at their disposal an annual appropriation of $165,000, made by the legislature of the state, available for current expenses. Salaries of instructors have already been materially advanced in some cases to a level which places the University of Minnesota in active competition with the leading universities of the country so far as the compensation of its instructors is concerned. This must be regarded as a very important advance in the development of state universities. Its economic importance as bearing upon the general problem of the compensation of teachers is even greater, for the alumni of Minnesota appealed not only to loyalty and benevolence, but to a legislature responsible for the proper support of the first educational institution in its state. They carried through

their appeal with energy and success, in the face of strong opposition and without the heartiest cooperation on the part of the board of regents. The campaign was conducted by a committee of alumni, ably seconded by the *Minnesota Alumni Weekly*. The sum originally desired was $200,000, but the regents voted to ask for only $150,000. Yet the amount granted was $165,000. The issues of the *Minnesota Alumni Weekly* ever since the movement began have contained a quantity of valuable material bearing on the general subject. Statistics were gathered the country over, and the relation of teachers' salaries to incomes from other professions and to the cost of living was set forth. In addition, the *Weekly* published letters from various sources expressing hearty interest in the campaign. From all parts of the state committees of alumni and individuals addressed the members of the legislature on behalf of the movement. As a result, when the legislature came to make up its appropriations for the university fund, it was confronted not with the question whether salaries should be raised, but with the question to what extent they should be raised. We believe that educators generally have grounds for congratulations on this successful movement. Here is a case where the needs of higher education have been put definitely before the people of one of our most important states, and they have responded in a way which indicates a high appreciation of their economic responsibility. Their action is a challenge to emulation.—*Columbia University Quarterly.*

THE AWARD OF THE BOYDEN PREMIUM BY THE FRANKLIN INSTITUTE

In 1859, Uriah A. Boyden, Esq., in his day an eminent mechanical engineer, of Boston, Mass., deposited with the Franklin Institute the sum of one thousand dollars, to be awarded as a prize to any resident of North America, who should determine by experiment whether all rays of light and other physical rays are or are not transmitted with the same velocity.

The Franklin Institute has religiously advertised the proposition of Mr. Boyden since that time until the present, inviting investigators to compete for the premium. During this period, which covers almost fifty years, a large number of essays, possibly as many as 25 or 30, have been presented by investigators for this award, but after careful investigation by a competent committee, appointed in each case, none was found sufficiently meritorious to warrant the institute in granting the prize, until the recent investigation by Dr. Paul R. Heyl, assistant in the department of chemistry of the Central High School of Philadelphia, which, in accordance with the prescribed conditions, was submitted anonymously. This communication was referred to a special committee, consisting of Messrs. Hugo Bilgram, mechanical engineer; Professor Arthur W. Goodspeed, of the department of physics of the University of Pennsylvania, and Dr. George Flowers Stradling, of the department of physics of the Northeast Manual Training School of Philadelphia, who reported unanimously in favor of awarding the Boyden prize for an essay submitted under the pseudonym 'Algol.' The name of the author was only disclosed after the investigators had upon careful examination proved its merits. An abstract of the committee's report follows, which will indicate the extremely delicate nature of the tests required in the investigation.

The applicant 'Algol' for the Boyden premium has succeeded in demonstrating, by experiment, that those of the ultra-violet rays of light, for which glass is transparent, have the same velocity as the light rays proper.

He reasons that if the velocity of these rays were different, they would not arrive, from a distant source, at the same time. For his test he selected 'algol,' a well-known variable star in the constellation Perseus, as the source of light. By means of a diffraction grating he eliminated all but the ultra-violet rays of a known frequency, and by focussing them on a sensitive plate, obtained photographs of the star.

For the purpose of identifying the rays so recorded with the visible rays, regarding the time of their emission, he selected, for the time of his test, the time during which the

light of this star shows the peculiar phenomenon of fading and recovering. The period of this variation is known to be about six hours. During this period he took a number of photographs, one half hour apart, each exposure being twenty minutes, the remaining ten minutes being employed for making the necessary preparations for the next exposure. He thus obtained a number of exposures of the star on the same sensitive plate, but shifted in position. After developing the plate, the successive images plainly showed a fading and recovering, and although the exact location of the minimum brightness could not, in the nature of things, be absolutely determined, the approximate coincidence of the time of the minimum brightness of the visible and the photographed rays was obvious. These tests were repeated a number of times to eliminate the possibility of error and also to take in a certain range of the ultra-violet rays, and since favorable opportunity for making these tests is not frequent, the investigation extended over a period of two years.

The applicant then reasoned as follows: Assuming that the photographic minimum did not exactly coincide with the observed visual minimum, their difference did certainly not exceed an hour, and since the distance of Algol is no less than forty light years, the difference of the velocities of the ultra-violet, and the visual rays could not exceed one part in 250,000. This close approximation establishes equality to all intents and purposes.

At the stated meeting of the Franklin Institute, held on June 19, 1907, the recommendation of the board of managers that the committee's report be approved and the Boyden prize awarded to Dr. Paul R. Heyl was unanimously adopted, and the author will consequently receive this long-delayed and much-coveted award.

SCIENTIFIC NOTES AND NEWS

THE council of the British Association for the Advancement of Science has nominated Mr. Francis Darwin, F.R.S., foreign secretary to the Royal Society, author of important papers on physiological botany and of the 'Life and Letters of Charles Darwin,' to be president of the meeting next year, when, for the fourth time, the association will assemble in Dublin.

ON the occasion of the celebration of the bicentenary of the birth of Linnæus, the Linnean gold medal of the Royal Swedish Academy was awarded to Sir Joseph Hooker.

AT the annual meeting of the American Academy of Arts and Sciences, on May 8, 1907, it was voted to award the Rumford premium to Mr. Edward Goodrich Acheson for the application of heat in the electric furnace to the industrial production of carborundum, graphite and other new and useful substances.

M. H. LE CHATELIER has been elected a member of the section of chemistry of the Paris Academy of Sciences in the room of the late M. Moissan.

PROFESSOR THEODORE W. RICHARDS, the present holder of the Harvard professorship in the University of Berlin, gave an address upon 'Neuere Untersuchungen über Atomgewichte,' to the German Chemical Society in the Hofmann Haus in Berlin, on the evening of June 1. At the address and at the dinner following there were present among many others: Professors Emil Fischer, Landolt, Nernst, Warburg, Planck, Ladenburg, Graebe, Liebermann, Gabriel, Le Blanc, and Brauner.

A PORTRAIT of President Eliot by Mr. John P. Sargent has been unveiled in the Harvard Union in connection with the commencement exercises of the university. The portrait was a gift to President Eliot on his seventieth birthday, chiefly by the alumni of the class of 1904.

PROFESSOR A. E. VERRILL, who has held the chair of zoology and the curatorship of the zoological department of the Peabody Museum at Yale University since 1864, will retire from active service at the close of the present year.

PROFESSOR GEORGE C. COMSTOCK, director of the Washburn Observatory, University of Wisconsin, was honored with the degree of doctor of laws by the University of Illinois at

its commencement on June 12. A week later the University of Michigan conferred upon him the honorary degree of doctor of science.

Among the recipients of the honorary degree of doctor of laws, at the commencement commemorating the fiftieth anniversary of the foundation of Washington University, was Professor William Trelease, who has held the chair of botany in the institution since 1885.

The Western University of Pennsylvania has conferred its doctorate of laws on Daniel Webster Hering, professor of physics in New York University, and its doctorate of science on Arthur Arton Hamerschlag, director of the Carnegie Technical Schools at Pittsburgh.

Mr. John Fritz, pioneer in the iron and steel industry in the United States, has received the degree of doctor of engineering at the Stevens Institute of Technology.

On the occasion of the sixty-third annual commencement of the University of Michigan the honorary degree of doctor of laws was conferred upon the Count de Montessus de Ballore, the distinguished French seismologist.

On the occasion of the celebration of the seventy-fifth anniversary of the foundation of Lafayette College, the addresses were made by Professor J. McKeen Cattell, of Columbia University, Professor W. B. Owen, of the college, and Professor Hugo Münsterberg, of Harvard University. The degree of doctor of letters was conferred on Professor Münsterberg, and the degree of doctor of laws on Professor Cattell. The degree of doctor of laws was also conferred on Dr. E. W. Morley, formerly professor of chemistry at Western Reserve University, and the degree of doctor of science on Dr. Frederick Starr, associate professor of anthropology in the University of Chicago.

Beginning on Monday, June 24, Professor Louis Kahlenberg will deliver a course of fifteen lectures on modern chemistry at the University of Washington, Seattle. In addition he will also give two lectures of a popular nature on the subjects, 'The Human Side of Some Great Chemists' and 'The Pure Food Movement.'

Dr. Fridtjof Nansen, the president for the current year of the Social and Political Education League, delivered his presidential address, in the botanical theater of University College, Gower Street, on June 26, his subject being 'Science and Ethical Ideas.' Sir Oliver Lodge presided.

In accordance with the standing agreement between Harvard University and the Cultusministerium of the German government the university has designated as visiting professor at Cambridge, for the year 1907–8, Paul Clemen, Ph.D., professor of the history of art at the University of Bonn, and provincial conservator of the Rhine Province.

Chancelor E. B. Andrews, of the University of Nebraska, has been given a leave of absence for four months, during which he will travel in Europe. Dean Charles E. Bessey will again be the acting chancelor.

Dr. L. O. Howard, chief of the Bureau of Entomology of the Department of Agriculture and permanent secretary of the American Association for the Advancement of Science, who has been in Europe to secure parasites to prey on the gypsy and brown-tail moths, has sailed from Liverpool to New York.

Professor Charles Schuchert, of Yale University, curator of the geological collection and head of Peabody Museum, will spend the summer, with two assistants, in an extensive geological excursion. The party will start early in July and will examine, in order, the coast formations and marl beds of New Jersey, the Appalachian Mountain formations in Western Maryland, above Harper's Ferry, and the fossil formations of the Devonian and Silurian Age in Western Tennessee. The last part of the summer will be spent in the Arbuckle Mountains of Oklahoma, tracing the sequence of the geological formations.

Dr. Ernst A. Bessey, pathologist in the U. S. Department of Agriculture, in charge of the Subtropical Laboratory at Miami Florida, has been making an extended tour of inspection through the gulf states, and across Texas, New Mexico and Arizona to California, Nevada, Utah, Colorado, Kansas and Ne-

braska, for the purpose of studying certain plant diseases in the field. He returned to Florida in the latter part of June.

F. C. LINCOLN, lately fellow in geology at Columbia University, has gone to Alaska for the summer in his professional capacity of mining engineer.

MR. CHARLES LOUIS POLLARD, formerly assistant curator of the division of plants in the United States National Museum, and more recently botanical editor for the G. and C. Merriam Company, of Springfield, Mass., has been appointed curator of the Staten Island Association of Arts and Sciences. Pending the removal of the museum of the latter to the quarters assigned to it in the new Richmond borough building the temporary office of the curator is in Room 18 of the Staten Island Academy at New Brighton. Mr. Pollard recently returned from a lecture tour in New England and Canada in aid of the cause of plant protection, the trip being made under the auspices of a grant from the Stokes fund of the New York Botanical Garden.

HENRY G. HANKS, at one time state geologist of California, and author of contributions to geology and chemistry, died at Alameda, Cal., on June 19, aged eighty-one years.

DR. ALEXANDER STEWART HERSCHEL, F.R.S., honorary professor of physics at the Durham College of Science, died on June 18. Professor Herschel died at the Observatory House, Slough, Buckinghamshire, where his father and grandfather made their great discoveries.

DR. L. FISCHER, honorary professor of botany at Bern, has died at the age of seventy-nine years.

THERE will be a civil service examination on July 10 for the position of assistant in soil bacteriology in the Bureau of Plant Industry at a salary of $1,400, and for the position of laboratory aid in economic botany at a salary of $600.

THE Japanese government announces an appropriation of $5,000,000 for the international exposition to be held at Tokyo in 1912. The money is to be paid in installments from 1908 to 1914.

THE next Esperanto Congress will be held at Cambridge, where the delegates will be the guests of the university.

IT is reported from Ottawa, Canada, that the Georgian Bay Canal Commission has practically completed, at a cost of some $600,000, a thorough survey of the proposed 21-foot waterway from Georgian Bay to Montreal *via* the French River, Nipissing, and the Ottawa River. The engineers of the commission have not compiled a final estimate as to the whole cost of the canal, but from information now available it is stated that the total expenditure required for a continuous and easily navigable waterway, with a minimum depth of 21 feet from Georgian Bay to tide water, will be close to $105,000,000. It is said that the canal will shorten the distance from Fort William, on Georgian Bay, to Montreal by over 400 miles. It is estimated that with the completion of the canal there will be 500,000 horsepower available along its course—almost as much as is available at Niagara. With so much cheap power available and with its great resources of iron ore and timber the Ottawa Valley is expected to become one of the greatest manufacturing centers of the continent. Referring to the early construction of the canal, Sir Wilfrid Laurier recently said that if he had the money to do so he would begin work immediately.

UNIVERSITY AND EDUCATIONAL NEWS

WE noted last week that the legislature had increased the appropriation of the University of Michigan from one fourth to three eighths of a mill. It may be further added that this will give the university the sum of $650,000 a year. The additional increase, together with the readjustment of values, which was accomplished last year, added about $250,000 to the annual income of Michigan.

AT the annual alumni dinner of Vanderbilt University on June 17 Chancelor Kirkland announced a gift of $100,000 from Mr. W. K.

Vanderbilt, of New York, grandson of the founder of the university.

Notice has been received from the administrator of the estate of Eliza O. Ropes, late of Salem, Mass., that her will provides for a gift to Harvard University of about seven hundred and thirty shares of common stock of the Boston and Maine Railroad for the establishment of the Nathaniel Ropes professorship of political economy, any annual income not needed for the salary of the incumbent to be given to the Peabody Museum of American Archeology and Ethnology. The will also gives about ten thousand dollars for the establishment of the Nathaniel Ropes Jr. scholarship fund.

By the will of Miss Catherine L. R. Catlin, New York University has received $10,000 for the establishment of a scholarship.

The summer course in the forestry school of Yale University, which constitutes the first term of the junior year, will open its session of seven weeks on Friday, July 5, at Milford, Pike County, Pa. Through the generosity of James W. Pinchot, six buildings, including an experiment station with tracts of land amounting to 200 acres have been provided for the use of the students in this preliminary summer work.

The daily papers state that President Benjamin Ide Wheeler, of the University of California, formerly professor of Greek at Cornell University, has declined the offer of the executive committee to nominate him for the presidency of the Massachusetts Institute of Technology. It is said that President Wheeler's salary at the University of California is $10,000, and that he would have received $15,000 at the institute. It is further reported that Dr. Henry S. Pritchett, president of the Carnegie Foundation, who has retained the presidency of the institute until a president should be found, will retire on July 1, and that Dr. William A. Noyes, professor of chemistry in the institute, will be made acting-president.

After thirty-nine years of continuous service Professor William Willard Daniells, of the chemical department of the University of Wisconsin, has been made professor emeritus. Professor Louis Kahlenberg, hitherto professor of physical chemistry, has been made professor of chemistry and head of the chemical department. He will hereafter deliver the basal lectures in general chemistry and will also lecture on physical chemistry and personally supervise chemical researches, especially in physical chemistry.

At Western Reserve University, Dr. Olin Freeman Tower has been promoted to be professor of chemistry and head of the chemical laboratory in Adelbert College, and Dr. Harry W. Springsteen has been appointed instructor in physics. In the Woman's College, Dr. Hippolyte Gruener has been promoted to a professorship of chemistry.

Ralph S. Lillie, Ph.D., Johnston scholar in physiology in the Johns Hopkins University and instructor in general and comparative physiology in the Marine Biological Laboratory, has been appointed instructor in physiological zoology in the University of Pennsylvania.

At a recent meeting of the board of regents of the State University of Iowa, Assistant Professor Byron J. Lambert was appointed professor of structural engineering; new instructorships in civil engineering and in descriptive geometry and drawing were created; and an extension of the engineering building more than doubling its present capacity was ordered.

At the June meeting of the regents of the University of Nebraska Dr. Elda R. Walker was advanced from an instructorship, to the adjunct professorship of botany. At the same meeting Raymond J. Pool, A.B., was elected to an instructorship in botany.

J. C. McLennan, B.A., Ph.D., for some years director of the Physical Laboratory, has been elected to the professorship of physics in the University of Toronto, in succession to ex-President James Loudon, LL.D.

Mr. George A. Carse, M.A., B.Sc., has been appointed university lecturer and assistant in natural philosophy in Edinburgh University, in room of Dr. William Peddie.

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